



Calhoun: The NPS Institutional Archive

Theses and Dissertations

Thesis Collection

1948

An investigation of prestressed concrete structures

Zechella, Alexander Philip

Rensselaer Polytechnic Institute

<http://hdl.handle.net/10945/6464>



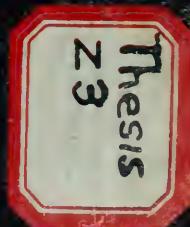
Calhoun is a project of the Dudley Knox Library at NPS, furthering the precepts and goals of open government and government transparency. All information contained herein has been approved for release by the NPS Public Affairs Officer.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

<http://www.nps.edu/library>

AN INVESTIGATION OF PRESTRESSED
CONCRETE STRUCTURES

ALEXANDER PHILIP ZECHELLA
AND
BRYAN SEVERANCE PICKETT



Postgraduate School.
U. S. Naval Academy,
Annapolis, Md.

AN INVESTIGATION OF
PRESTRESSED CONCRETE STRUCTURES

BY
E. H.

A THESIS PRESENTED TO THE FACULTY
OF RENSSELAER POLYTECHNIC INSTITUTE
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR DEGREE OF
MASTER OF CIVIL ENGINEERING

BY

ALEXANDER PHILIP ZIONELLA

AND

BRYAN SEVERANCE PICKETT

TROY, NEW YORK

MAY, 1940

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES

Thesis
23

PHYSICS DEPARTMENT
UNIVERSITY OF CHICAGO
CHICAGO, ILLINOIS
JANUARY 1962

BY
JAMES H. HARRIS
PH.D.
PHYSICS DEPARTMENT
UNIVERSITY OF CHICAGO
JANUARY 1962

PREFACE

The object of this thesis is three-fold; first, to present a paper in which a correlation has been made of the existing theories and design formulae pertinent to the subject of prestressed concrete; second, to apply these existing theories to the design of a particular structure and third, to compare the structure so designed to a similar structure using conventional reinforced concrete design procedures.

In the accomplishment of these objectives the authors have made no attempt to present original theories in the derivation of the design formulae.

THE
JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE
OF GREAT BRITAIN AND IRELAND
VOLUME 40
PART 1
1910

The object of this issue is to present a paper in which a contribution has been made to the study of the human mind and its development in the light of the latest researches in the field of psychology and the allied sciences. The paper is written by a leading authority on the subject and is of great interest and value to all those who are concerned with the study of the human mind and its development. The paper is written in a clear and concise manner and is well illustrated with diagrams and figures. It is a valuable contribution to the literature of the subject and is highly recommended to all those who are interested in the study of the human mind and its development.

THE
JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE
OF GREAT BRITAIN AND IRELAND
VOLUME 40
PART 1
1910

ACKNOWLEDGEMENT

The authors wish to express their appreciation to Associate Professor Joseph S. Kinney of the Department of Civil Engineering for his guidance in the selection of this subject and for his suggestions which aided the authors in reaching a conclusion.

INTRODUCTION

The development of the theory of prestressing various concrete structures is not entirely new, nor is the application of the theory to actual construction unknown by any means. For certain structures such as circular pressure vessels this type of construction is widely used. For other structural members, especially straight line components, the application is much more limited at the present time. The authors feel that the advantages to be gained by using prestressing in all types of construction will eventually become more widely known, and hence the process will find ever-increasing application.

The objective of prestressing concrete construction is to eliminate concrete tensile stresses under design load conditions. This enables the designer to utilize the higher compressive stresses of modern concrete and the high tensile properties of cold drawn steel wire.

In general, the establishment of prestressing is accomplished by tensioning the steel reinforcement before the load is applied, the stretching force being transmitted to the concrete as a compressive force after the concrete has attained sufficient strength to take the stresses thus applied. In this manner, stresses of opposite sign to those occurring under load are imparted to the structure.

One of the first proposals to use prestressing was made by Jackson in 1888. The method suggested was that of strengthening the structure by tightening the reinforcement to a degree not determinate.

The development of the theory of probability is a process of continuous growth. It is not only a matter of the application of the theory to new problems, but also a matter of the development of the theory itself. The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

which is

In general, the development of probability is a process of continuous growth. It is not only a matter of the application of the theory to new problems, but also a matter of the development of the theory itself. The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

One of the first problems in the development of probability is the problem of the definition of probability. The theory of probability is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance. It is a branch of mathematics which is concerned with the study of the laws of chance.

The idea was carried further by Mandl who established a limit to the concrete tensile stress and to the reduction in cracking. In his work he did not, however, consider losses of the initial prestress and hence the counteraction due to stretching the reinforcement was only partially effective. Later work in this field by Dill, Hewett, Frayssinet, and others arrived at a process whereby full prestressing was utilized, all possible losses being considered and cracklessness being guaranteed due to the absence of any tensile stresses in the concrete under load.

The most recent work in prestressing aims at refinements to the early propositions. Various means have been advanced to achieve the desired degree of prestressing and the application of the process has been extended.

In general, two methods of applying the initial prestress are used; pre-stretching and post-stretching. The terms indicate whether the tensioning is carried out before or after hardening of the concrete. With pre-stretching, the concrete remains in the mold until the stretching can be transmitted to the concrete by bond. At the outset the tensile force in the steel is taken at the ends of the mold by special anchorages which are subsequently removed.

Post-stretching is applied when the concrete has hardened. In this case permanent anchorages at the ends of the structure transmit the compression to the concrete, there being no bond between the concrete and the steel.

With pre-stretching, at the release of the stretching force to the concrete, the initial prestress is immediately reduced due to the elastic deformation of the concrete and to shrinkage, which losses are increased gradually by further shrinkage and by plastic flow of the concrete. With post-stretching the losses due to elastic deformation and to the initial shrinkage are eliminated, thus the use of conventional steel is satisfactory.

In the design of prestressed structures the nature of the structure will determine which of the various systems of prestressing can be used most advantageously and which types of materials are best suited to the job. It must be decided whether full or partial prestressing will be used, based on the characteristics imparted by these two methods.

In full prestressing the stretching force is of such magnitude that no tensile stress occurs under working load and thus cracklessness of the concrete is guaranteed. This latter quality is, of course, highly desirable in pressure vessels such as pipes and tanks under pressure. Due to the fact that the concrete can be prevented from cracking the sections of concrete can be treated as a homogeneous material and the design is not, therefore, based on the "cracked section" as is the case in the conventional design. This absence of cracks and absence of tensile stresses in the concrete also increases the shear resistance of the concrete. In certain cases it allows the economical use of high strength steel. The strain of the structure at the release of compression to the concrete is greater than under working load,

which necessitates a high early compressive strength and which may cause inconvenience for transporting and handling precast products, since any additional strain has to be avoided.

In cases where absence of cracks is not necessary as in beams, for example, partial prestressing may be more advantageous. In this case a smaller stretching force is required and is applied to only part of the total reinforcement. This has an effect on the economy over full prestressing because of the reduction in fabrication costs and because of the greater ease of handling precast products. By controlling the degree of initial prestress the strain under working load (deflection in the case of beams) can be controlled so as to obtain any degree of deflection between the limits of the large deformations and heavy cracking of the non-prestressed structure and the extremely small deformation and absence of cracks in the fully prestressed structure.

In the design the losses of the initial prestress mentioned previously must be considered in order that the final compressive stress in the concrete prior to loading may be held within the limits desired. These losses are computed and allowance made for them in the particular case at hand by increasing the initial prestress in the steel.

THE UNITED STATES DEPARTMENT OF JUSTICE
WASHINGTON, D. C. 20535
OFFICE OF THE ATTORNEY GENERAL
DIVISION OF INVESTIGATION
UNITED STATES MARSHAL SERVICE
WASHINGTON, D. C. 20535

THE UNIVERSITY OF CHICAGO PRESS
54 EAST LAKE STREET
CHICAGO, ILLINOIS 60607
U.S.A.
LONDON: ROUTLEDGE Kegan Paul
27, AVONDALE ROAD, LONDON N1 1PL
ENGLAND
SINGAPORE: ROUTLEDGE Kegan Paul
20, MARINE DRIVE, SINGAPORE 05
MALAYSIA: ROUTLEDGE Kegan Paul
10, JALAN PANGLOSS, PETALING JAYA
SELANGOR, MALAYSIA
AUSTRALIA: ROUTLEDGE Kegan Paul
20, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
NEW ZEALAND: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
CANADA: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
INDONESIA: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
JAPAN: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
KOREA: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
NETHERLANDS: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
NORWAY: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
POLAND: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
RUSSIA: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
SPAIN: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
SWEDEN: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
SWITZERLAND: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
TAIWAN: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
THAILAND: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
UNITED KINGDOM: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
UNITED STATES: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585
VIETNAM: ROUTLEDGE Kegan Paul
100, ALEXANDRIA DRIVE, NORTH SYDNEY
NSW 1585

It is the policy of the United States to support the people of Cuba in their struggle for freedom and independence from the tyranny of the Cuban government. The United States will continue to provide moral and material support to the Cuban people and to the Cuban Revolution.

GENERAL THEORY OF DESIGN

The application of prestressing to particular structures will now be considered. Since prestressing is most advantageously used in pressure vessels, this type of structure will be considered first.

WIRE WOUND PRESTRESSED CONCRETE PRESSURE PIPE

Conventional reinforced concrete pipes have been used in water supply lines for many years within the limitations of internal pressures and external loadings; but with the comparatively recent development of wire wound prestressed concrete pipe greater internal pressures can be carried and greater resistance to external loading afforded.

The wire wound prestressed concrete pressure pipe has advantages of economy of steel and quality of concrete to satisfy engineering designs for high pressure heads. The magnitude of internal pressure resulting from hydrostatic head and external loadings, to be resisted by the pipe will govern the design for quantity of steel wire and the amount of prestress necessary to use in the wrapping.

Refer to Figure 5;

f_s stress in the steel, p.s.i.

f'_s stress in the steel due to internal pressure, p.s.i.

f_c stress in the concrete, p.s.i.

f'_c reduction in concrete prestress, p.s.i.

A_s area of steel, square inches.

A_c area of concrete, square inches.

r internal radius of pipe, inches.

...the ... of ...

[illegible]

- t wall or shell thickness, inches
 P internal pressure, p.s.i.
 E_s modulus of elasticity of steel, p.s.i.
 E_c modulus of elasticity of concrete, p.s.i.
 $n = E_s/E_c$
 d_s deformation in steel, inches per inch.
 d_c deformation in concrete, inches per inch.

1. When the shell is wound with a wire in tension there is produced:

- (a) a tensile stress in the wire, f_s .
 (b) a compressive stress in the concrete, f_c .

In this derivation the average stress in the steel and in the concrete is used. The stress in the steel must equal the stress in the concrete to maintain equilibrium, hence:

$$f_c A_c = f_s A_s$$

For 1 inch length of pipe $A_c = t$, then:

$$f_c = \frac{f_s A_s}{t}$$

2. When the prestressed pipe is subjected to internal pressure there is produced:

- (a) An increase in the steel prestress
 (b) A decrease in the concrete pre compression.

Hence, for equilibrium:

$$Pr = f'_s A_s + f'_c A_c$$

$$d_s = \frac{f'_s}{E_s} \quad \text{and} \quad d_c = \frac{f'_c}{E_c}$$

But $d_s = d_c$; therefore $\frac{f'_s}{E_s} = \frac{f'_c}{E_c}$

1. The first condition is that

2. The second condition is that

3. The third condition is that

4. The fourth condition is that

5. The fifth condition is that

6. The sixth condition is that

7. The seventh condition is that

8. The eighth condition is that

(a) The first condition is that

(b) The second condition is that

The third condition is that

The fourth condition is that

The fifth condition is that

The sixth condition is that

The seventh condition is that

The eighth condition is that

The ninth condition is that

The tenth condition is that

The eleventh condition is that

(a) The first condition is that

(b) The second condition is that

The third condition is that

The fourth condition is that

The fifth condition is that

The sixth condition is that

Whence $f's = f'e \frac{A_s}{A_c}$; but $\frac{E_s}{E_c} = n$

Hence $f'_s = f'e$ which is the increase in steel stress accompanying the decrease in concrete pre compression due to internal pressure. Since the concrete is assumed to take no tensile stress the limit of $f'e$ is the magnitude of the concrete prestress f_c , therefore:

$$Pr = n f_c A_s + f_c A_c; \quad A_c = t \text{ for 1" length}$$

$$P = f_c \frac{(n A_s + t)}{r}$$

$$f_c = \frac{Pr}{n A_s + t}$$

The curves shown in Figure 1 taken from an article by Ray S. Crepps in the A.C.I. Proceedings illustrate a simple means of design for any one particular pipe which is subjected to a varying hydrostatic head. By plotting both design equations on the same set of axes a convenient and rapid solution of the equations is available. An example to illustrate the use of these curves is as follows:

Suppose a pressure pipe with a head of 250 p.s.i. is to be used. Entering the curves with 250 p.s.i. and projecting horizontally to the internal pressure curve, then vertically to the steel area curve, read directly the area of steel necessary per foot of length of pipe; in this case 0.04 square inches per foot.

$$E = \frac{1}{2} \rho \int_{-L}^L \dot{y}^2 dx$$

From (7) we find that the rate of change of the energy is given by

$$\frac{dE}{dt} = \rho \int_{-L}^L \dot{y} \ddot{y} dx$$

which is zero if the boundary conditions are such that $\dot{y} = 0$ at $x = \pm L$.

$$E = \frac{1}{2} \rho \int_{-L}^L \dot{y}^2 dx$$

$$E = \frac{1}{2} \rho \int_{-L}^L \dot{y}^2 dx$$

$$E = \frac{1}{2} \rho \int_{-L}^L \dot{y}^2 dx$$

The energy is constant in time if the boundary conditions are such that $\dot{y} = 0$ at $x = \pm L$. In the case of a string fixed at both ends, the boundary conditions are $y = 0$ at $x = \pm L$. The energy is then constant in time.

$$E = \frac{1}{2} \rho \int_{-L}^L \dot{y}^2 dx$$

For a string fixed at both ends, the boundary conditions are $y = 0$ at $x = \pm L$. The energy is then constant in time.

CHAPTER IV. THE DESIGN OF PRESTRESSING

The next logical step in the use of prestressing would be in the construction of a water tank or stand pipe. The theory of design here presented was taken from an article published in the A.C.I. publication "R/C" which was written by Lt. Comd'r John L. Mason (CNC) USNR. Various other articles on the subject were studied in conjunction with the design presented in this thesis; however it is the opinion of the authors that Lt. Comd'r Mason has presented the most concise and logical development of the necessary design formulae. Only the most pertinent formulae will be presented here. For a more complete development, and for examples of uses of these formulae reference to Lt. Comd'r. Mason's article or the design herein presented is suggested.

Consider a ring of concrete with a band of steel laid snugly around its exterior surface but not stressed. By means of a turnbuckle or other mechanical device keep shortening the band until it is stressed to f_{si} , the initial steel stress. The total initial force on the steel band will be $A_s f_{si}$. This force must, of course, be in equilibrium with the forces in the concrete ring, hence:

$$A_s f_{si} = A_c f_{ci} \text{ or } f_{ci} = p f_{si} \text{ where } p = \frac{A_s}{A_c}$$

Suppose now that the pre-stressed ring is subjected to an internal hydrostatic pressure of q per unit of length and the radius of the ring is r ; then the ring tension, T in the combined concrete and steel section is;

$T = q R$. The tensile stresses due to ring tension are:

$$\text{for the concrete} = \frac{T}{(A_c + nA_s)}$$

$$\text{for the steel} = \frac{nT}{(A_c + nA_s)}$$

$$\text{where } n = \frac{E_s}{E_c}.$$

The combined final stresses are:

$$\text{for the concrete } f_c = -p f_{si} + \frac{T}{A_c (1 + np)}$$

$$\text{for the steel } f_s = f_{si} + \frac{T}{A_s (1 + np)}$$

As seen from the above equations the initial compressive stress in the concrete was reduced and the initial stress in the steel was increased. For complete insurance against cracking the usual procedure is to consider the combined stress in the concrete equal to zero. Setting the equation for final concrete stress equal to zero and solving for the initial steel stress we have:

$$f_{si} = \frac{T}{A_s (1 + np)}$$

When $f_c = 0$ the total ring tension must be taken by the steel, hence $T = A_s f_s$. Therefore for the initial steel stress we have:

$$f_{si} = \frac{f_s}{1 + np}$$

This is, however, based on the assumption that the concrete behaves as a perfectly elastic material with no shrinkage. This assumption is, of course, false and a correction to the initial stress must be taken into account due to actual shrinkage. The steel bands must be given an actual stress such that:

1. The first condition is that the function f is continuous on $[a, b]$.

$$\lim_{x \rightarrow a^+} f(x) = f(a)$$

$$\lim_{x \rightarrow b^-} f(x) = f(b)$$

$$f(a) = f(b)$$

The function f is continuous on $[a, b]$.

$$\lim_{x \rightarrow a^+} f(x) = f(a)$$

$$\lim_{x \rightarrow b^-} f(x) = f(b)$$

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

$$\lim_{x \rightarrow a^+} f(x) = f(a)$$

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

$$\lim_{x \rightarrow a^+} f(x) = f(a)$$

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

The function f is continuous on $[a, b]$.

$$f_{sl} = \frac{f_s + CEs}{1 + np} \quad \text{where } C =$$

shrinkage coefficient.

(For derivation of this latter equation see "Circular Concrete Tank Without Prestressing", A.C. I. "R/C" No. 4).

Lt. Comdr. Mason indicates that, from his experience, he has found the value of C to be approximately 0.0002 for tanks above ground level. He also indicates that the value of p should be limited to approximately 0.02.

From the maximum percentage of band steel an equation for minimum wall thickness t can be developed in terms of ring tension T :

$$P = \frac{A_s}{12t} = \frac{T/f_s}{12t}$$

$$t = \frac{T}{12pf_s}$$

Hence t = the minimum wall thickness that can be used. If the steel stress is constant throughout the entire height of wall then the thickness t must remain constant. By using the relation that $A_s = \frac{T}{f_s}$ the area of steel necessary at any point in the wall can be determined.

$$\frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m \frac{dv^2}{dt}$$

where m is the mass

and v is the velocity of the particle

which is the derivative of the position with respect to time

and $\frac{d}{dt}$ is the time derivative

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

$$\frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m \frac{dv^2}{dt}$$

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

$$\frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m \frac{dv^2}{dt}$$

which is the derivative of the position with respect to time

$$\frac{d}{dt} \left(\frac{1}{2} m v^2 \right) = \frac{1}{2} m \frac{dv^2}{dt}$$

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

which is the derivative of the position with respect to time

STRAIGHT LINE MEMBERS

A more recent application of the theory of prestressing, and one that is coming into prominence, is the application of the theory to straight line members such as beams, columns, and girders.

The theory applied to these elementary components may be carried into the construction of larger structures. It has been claimed by advocates of the theory that when applied to bridges there results a structure which gives excellent resistance to the effect of concentrated wheel loads, impact and vibrations. Long span bridges of the simple beam and cantilever type can be designed with a relatively small depth-span ratio combined with small deflections (according to Schorer).

The theory herein presented is taken from an article by Herman Schorer in the Journal of the American Concrete Institute. As previously stated in the introduction there is a loss in the initial steel prestress due to the following causes:

- (1) Shrinkage of the concrete.
- (2) Plastic flow of the concrete.
- (3) Elastic deformation of the concrete.

The total change in the initial stress in the steel may be given approximately by the following empirical formula:

$$\text{Change in } f_s = 15,000 + 15 f_o \quad (a)$$

Hence the final effective steel stress is:

$$f_s = f_{so} - \text{change in } f_s$$

A more perfect solution of the problem of the earth's structure is the subject of the present paper. It is the object of the present paper to show that the earth is not a homogeneous body, but that it is composed of several layers of different materials, and that these layers are separated by distinct boundaries.

The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.

The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.

- (1) The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age.
- (2) It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.
- (3) The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age.
- (4) It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.

The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.

The theory of the earth's structure is a subject of great importance, and one which has attracted the attention of many of the most distinguished scientists of the present age. It is a subject which has been the subject of much of the most valuable research of the present age, and it is one which has been the subject of much of the most valuable research of the present age.

The effective stress can be determined by means of successive approximations. For this purpose the entire original prestressed force P_0 is first assumed to be acting, whereby an approximate value of the concrete prestress is obtained. The corresponding steel stress reduction is then determined from the above equation. This approximation is then used to obtain a second approximation for the effective prestress force, and this procedure is repeated until the corrections become negligible.

A derivation of the design formulae for beams and girders follows:

Notation:

Change in f_g = total steel stress reduction.

f_g = effective concrete stress.

f_{so} = original steel stress.

P_0 = original steel prestress force.

f_{cep} = effective concrete stress at the c.g.c. due to prestress force, P .

M_p = internal moment, due to prestress force, P .

f_{c1p} = extreme concrete fiber stress due to prestress force, P .

f_{c2p} = extreme concrete fiber stress due to prestress force, P .

s_1 = S_{c1}/A .

s_2 = S_{c2}/A .

k_1 = f_{c1p}/f_{cep} , stress ratio.

k_2 = f_{c2p}/f_{cep} , stress ratio.

f_{cep} = effective concrete stress at the c.g.c. due to prestress force, P .

c_1 = extreme fiber distance from c.g.c.

c_2 = extreme fiber distance from c.g.c.

The following table shows the results of the analysis of the data for the various groups. The first column shows the group, the second column shows the number of subjects in each group, the third column shows the mean score for each group, and the fourth column shows the standard deviation for each group. The data are as follows:

Group	Number of Subjects	Mean Score	Standard Deviation
Group 1	10	12.5	2.5
Group 2	10	15.0	3.0
Group 3	10	17.5	3.5
Group 4	10	20.0	4.0
Group 5	10	22.5	4.5
Group 6	10	25.0	5.0
Group 7	10	27.5	5.5
Group 8	10	30.0	6.0
Group 9	10	32.5	6.5
Group 10	10	35.0	7.0

A comparison of the data for the various groups shows that the mean score increases as the group number increases. This is consistent with the hypothesis that the mean score increases as the group number increases.

The following table shows the results of the analysis of the data for the various groups. The first column shows the group, the second column shows the number of subjects in each group, the third column shows the mean score for each group, and the fourth column shows the standard deviation for each group. The data are as follows:

Group	Number of Subjects	Mean Score	Standard Deviation
Group 1	10	12.5	2.5
Group 2	10	15.0	3.0
Group 3	10	17.5	3.5
Group 4	10	20.0	4.0
Group 5	10	22.5	4.5
Group 6	10	25.0	5.0
Group 7	10	27.5	5.5
Group 8	10	30.0	6.0
Group 9	10	32.5	6.5
Group 10	10	35.0	7.0

A comparison of the data for the various groups shows that the mean score increases as the group number increases. This is consistent with the hypothesis that the mean score increases as the group number increases.

The following table shows the results of the analysis of the data for the various groups. The first column shows the group, the second column shows the number of subjects in each group, the third column shows the mean score for each group, and the fourth column shows the standard deviation for each group. The data are as follows:

Group	Number of Subjects	Mean Score	Standard Deviation
Group 1	10	12.5	2.5
Group 2	10	15.0	3.0
Group 3	10	17.5	3.5
Group 4	10	20.0	4.0
Group 5	10	22.5	4.5
Group 6	10	25.0	5.0
Group 7	10	27.5	5.5
Group 8	10	30.0	6.0
Group 9	10	32.5	6.5
Group 10	10	35.0	7.0

A comparison of the data for the various groups shows that the mean score increases as the group number increases. This is consistent with the hypothesis that the mean score increases as the group number increases.

- $k_0 = f_{c02}/f_{c01}$, stress ratio.
 M_0 = dead load moment.
 e = distance between center gravity concrete and neutral axis.
 A = area of transformed section.
 A_s = steel area.
 f'_{c1m} = concrete fiber stress change due to external moment, M.
 f'_{c2m} = concrete fiber stress change due to external moment, M.
 f'_{cm} = concrete stress change at the c.g.c. due to external moment, M.
 f_{sm} = steel stress change due to live load moment, M.
 S_{c1} = section modulus of fiber c_1 , referred to c.g.c.
 S_{c2} = section modulus of fiber c_2 , referred to c.g.c.
 M = live load moment.

Figure 6 shows a beam section with an effective prestress force, P acting at the distance, e , from the c.g.c. The average effective concrete stress is,

$$f_{c0p} = \frac{P}{A_c} \quad (1)$$

The eccentric application causes an internal moment,

$$M_p = eP \quad (2)$$

The extreme fiber stresses are,

$$f_{c1p} = \frac{P}{A_c} + \frac{eP}{S_{c1}} \quad (3)$$

$$f_{c2p} = \frac{P}{A_c} - \frac{eP}{S_{c2}} \quad (4)$$

By designating,

$$n_1 = \frac{S_{c1}}{A_c} \quad (5)$$

1. The first step is to determine the total number of items in the sample.

2. The second step is to determine the number of items in each category.

3. The third step is to calculate the relative frequency of each category.

4. The fourth step is to multiply the relative frequency by the total number of items.

5. The fifth step is to round the result to the nearest whole number.

6. The sixth step is to check the results to ensure they add up to the total number of items.

7. The seventh step is to present the results in a clear and concise manner.

8. The eighth step is to provide a brief summary of the findings.

9. The ninth step is to conclude the analysis.

10. The tenth step is to provide a final report.

11. The eleventh step is to review the report for accuracy.

12. The twelfth step is to submit the report to the appropriate authority.

13. The thirteenth step is to follow up on any feedback received.

14. The fourteenth step is to archive the report for future reference.

15. The fifteenth step is to end the process.

16. The sixteenth step is to provide a final summary.

17. The seventeenth step is to conclude the analysis.

18. The eighteenth step is to provide a final report.

19. The nineteenth step is to review the report for accuracy.

20. The twentieth step is to submit the report to the appropriate authority.

21. The twenty-first step is to follow up on any feedback received.

22. The twenty-second step is to archive the report for future reference.

23. The twenty-third step is to end the process.

24. The twenty-fourth step is to provide a final summary.

25. The twenty-fifth step is to conclude the analysis.

26. The twenty-sixth step is to provide a final report.

27. The twenty-seventh step is to review the report for accuracy.

28. The twenty-eighth step is to submit the report to the appropriate authority.

29. The twenty-ninth step is to follow up on any feedback received.

30. The thirtieth step is to archive the report for future reference.

And,

$$e_2 = \frac{Ne_2}{A_0} \quad (6)$$

The fiber stresses are then determined by means of stress ratios;

$$k_1 = \frac{f_{o1s}}{f_{oep}} = \left(1 + \frac{e}{s_1} \right) \quad (7)$$

and,

$$k_2 = \frac{f_{o2s}}{f_{oep}} = \left(1 - \frac{e}{s_2} \right) \quad (8)$$

The concrete stress at the c.g.s. is,

$$f_{oep} = f_{o1s} - (f_{o1s} - f_{o2s}) \frac{(C_1 - e)}{C_1 + C_2} \quad (9)$$

which after transformation gives,

$$f_{oep} = \frac{(1 + e^2/A_0)}{I_0} \quad (10)$$

or by introducing the stress ratio,

$$k_0 = \frac{f_{oep}}{f_{o1s}} = \frac{I_0}{I_0} \quad (11)$$

the effective steel stress is,

$$f_{ep} = \frac{P}{A_0} \quad (12)$$

The originally required steel stress can now be determined by substituting f_{ep} in equation (a),

$$\text{Change in } f_s = f_{ep} + 15 f_c$$

The designer is now confronted with the opposite problem; that is, the determination of the effective stress due to the release of the original prestress force, P_0 , also the simultaneous influence of dead loads.

$$(A) \quad \frac{1}{2} \frac{d^2 x}{dt^2} = -\frac{1}{2} \frac{d^2 y}{dt^2}$$

The above equation can be integrated by taking the initial conditions

$$(V) \quad \left(\frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0 \right)$$

$$(B) \quad \left(\frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0 \right)$$

$$(C) \quad \frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0$$

$$(D) \quad \frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0$$

$$(E) \quad \frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0$$

$$(F) \quad \frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0$$

The following equation can be integrated by taking the initial conditions

$$(G) \quad \frac{1}{2} \frac{dx}{dt} = 0, \frac{1}{2} \frac{dy}{dt} = 0$$

The following equation can be integrated by taking the initial conditions

The following equation can be integrated by taking the initial conditions

The following equation can be integrated by taking the initial conditions

If the dead load moment, M_0 , is smaller than the counteracting prestress moment, equation (2), the release of the prestress force will cause the beam to lift off the supporting forms. In this case the dead load acts simultaneously with the prestress load and the steel stress loss is determined by the combined concrete stress at the o.g.c. The concrete stress, f_{c0M_0} , due to dead load moment is,

$$f_{c0M_0} = \frac{M_0}{S_e} \quad (13)$$

The effective stresses are preferably determined by the method of successive approximations. For this purpose the known value of P_0 , instead of P is at first substituted in equation (1), which results in an approximate stress f_{ceP} as derived from equation (11). This stress is combined with the given dead load stress, equation (13). The resulting stress, substituted in change of prestress equation, gives an approximation for the total steel stress reduction; therefore a correction for the effective prestress force.

The effective fiber stresses are now obtainable from equations (7) and (8) by means of the final value of P , as substituted in equation (1). In the case of top and bottom reinforcing the corrections should be made simultaneously, although the two prestress forces can be treated independently as a first approximation.

The stress changes due to live loads must now be considered. The stress changes due to live loads are based on the transformed section, assuming that volume changes can be considered as completed. The transformed area, A , is based on the entire concrete section,

$$A = A_c + nA_s \quad (14)$$

It was found that the...

...the results of the present work...

...the results of the present work...

...the results of the present work...

111

Page 2 30

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

...the results of the present work...

112

Page 2 31

With reference to Figure 6 the location of the neutral axis is given by the relation,

$$a = \frac{c n A_s}{A} \quad (15)$$

$$I = I_c + a^2 A_c + (e - a)^2 n A_s \quad (16)$$

or,

$$I = I_c + a n I_c \quad (17)$$

With $c'_1 = c_1 - a$ the section modulus for the bottom fiber becomes,

$$S'_{c1} = \frac{I}{c'_1} \quad (18)$$

For the top fiber, with $c'_2 = c_2 + a$,

$$S'_{c2} = \frac{I}{c'_2} \quad (19)$$

For the c.g.s. with $e' = e - a$,

$$S'_e = \frac{I}{e'} \quad (20)$$

The concrete stress changes produced by the live load moment, M , then are,

$$f'_{c1m} = \frac{M}{S'_{c1}} \quad (21)$$

$$f'_{c2m} = \frac{M}{S'_{c2}}$$

$$f'_{cem} = \frac{M}{S'_e}$$

and the steel stress change, from equation $f_s = n f_c$ becomes,

$$f_{sm} = n f'_{cem}.$$

(11)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2}$$

(12)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3}$$

(13)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4}$$

(14)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5}$$

(15)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6}$$

(16)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6} + \frac{1}{\Delta_7}$$

(17)

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6} + \frac{1}{\Delta_7} + \frac{1}{\Delta_8}$$

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6} + \frac{1}{\Delta_7} + \frac{1}{\Delta_8} + \frac{1}{\Delta_9}$$

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6} + \frac{1}{\Delta_7} + \frac{1}{\Delta_8} + \frac{1}{\Delta_9} + \frac{1}{\Delta_{10}}$$

$$\frac{1}{\Delta} = \frac{1}{\Delta_1} + \frac{1}{\Delta_2} + \frac{1}{\Delta_3} + \frac{1}{\Delta_4} + \frac{1}{\Delta_5} + \frac{1}{\Delta_6} + \frac{1}{\Delta_7} + \frac{1}{\Delta_8} + \frac{1}{\Delta_9} + \frac{1}{\Delta_{10}} + \frac{1}{\Delta_{11}}$$

COMPARATIVE DESIGN

The purpose of this comparative design is to arrive at a measure of the relative economy of materials required for a structure designed first, by conventional reinforced concrete design procedure and second, by using the theories of prestressed structures. For the purpose of an overall economic study such a comparison of designs should, of course, take into account the relative costs of fabrication and the labor charges. A determination of these latter factors is, however, beyond the scope of this study; hence the comparison will be based solely upon the quantity of materials required in each case.

For the purpose as outlined above the structure to be compared will be a 500,000 gallon circular water storage tank. The comparison will be extended in the case of the tank cover to include a flat slab cover in one case and a segmental dome cover in the other. These types were chosen as being best suited to the individual tank designs.

Notation

- A_c = area of concrete section, square inches.
- A_s = area of steel in tension, square inches.
- b = width of rectangular beam, inches.
- ϵ = shrinkage coefficient of concrete.
- d = effective depth, inches.
- D = diameter of tank, feet.
- E_c = modulus of elasticity of concrete in compression, p.s.i.
- E_s = modulus of elasticity of steel, p.s.i.

REMARKS

The first of the two main objects of the present report is to describe the results of the investigation of the physical properties of the various specimens of the material under consideration. The second object is to compare the results of the present investigation with the results of previous investigations of the same material. The third object is to discuss the results of the present investigation in relation to the theory of the physical properties of the material under consideration.

The first part of the report describes the results of the investigation of the physical properties of the various specimens of the material under consideration. The second part of the report compares the results of the present investigation with the results of previous investigations of the same material. The third part of the report discusses the results of the present investigation in relation to the theory of the physical properties of the material under consideration.

CONCLUSIONS

1. The results of the investigation of the physical properties of the various specimens of the material under consideration are as follows:
2. The results of the present investigation are in good agreement with the results of previous investigations of the same material.
3. The results of the present investigation are in good agreement with the theory of the physical properties of the material under consideration.
4. The results of the present investigation are in good agreement with the results of previous investigations of the same material.
5. The results of the present investigation are in good agreement with the theory of the physical properties of the material under consideration.
6. The results of the present investigation are in good agreement with the results of previous investigations of the same material.
7. The results of the present investigation are in good agreement with the theory of the physical properties of the material under consideration.
8. The results of the present investigation are in good agreement with the results of previous investigations of the same material.
9. The results of the present investigation are in good agreement with the theory of the physical properties of the material under consideration.
10. The results of the present investigation are in good agreement with the results of previous investigations of the same material.

f_c = compressive unit stress in extreme fiber of concrete, p.s.i.
 f'_c = ultimate compressive strength of concrete, p.s.i.- at age of 28 days.
 f_s = tensile unit stress in longitudinal reinforcement, p.s.i.
 f_{s1} = initial stress in steel, p.s.i.
 f_{c1} = initial stress in concrete, p.s.i.
 H = height of wall, feet.
 H_1 = hoop stress in dome at point 1, kips per foot.
 I = moment of inertia of horizontal cross section of tank, inch units.
 I_s = moment of inertia of reinforcement about neutral axis, inch units.
 j = ratio of distance between centroid of compression and center of gravity of tensile reinforcement to depth "d",
 k = ratio of distance between the compressive face of the beam and the neutral axis to the depth "d".
 M = moment due to dead and live loads, foot pounds.
 n = ratio of modulus of elasticity of steel to that of concrete.
 p = ratio of area of tensile reinforcement to the effective area of concrete in beams and slabs.
 r = radius of sphere, feet.
 R = radius of tank, feet.
 S_0 = compression in edge member of lantern opening of dome, kips.
 S_1 = ring tension in edge member of dome, kips.
 t = thickness of beam or wall, inches.
 T = hoop stress, pounds.
 T_1 = meridional stress in dome, kips per foot.

1. The first of these is the fact that the system is not a simple one, but a complex one, involving many different factors.
2. The second is the fact that the system is not a simple one, but a complex one, involving many different factors.
3. The third is the fact that the system is not a simple one, but a complex one, involving many different factors.
4. The fourth is the fact that the system is not a simple one, but a complex one, involving many different factors.
5. The fifth is the fact that the system is not a simple one, but a complex one, involving many different factors.
6. The sixth is the fact that the system is not a simple one, but a complex one, involving many different factors.
7. The seventh is the fact that the system is not a simple one, but a complex one, involving many different factors.
8. The eighth is the fact that the system is not a simple one, but a complex one, involving many different factors.
9. The ninth is the fact that the system is not a simple one, but a complex one, involving many different factors.
10. The tenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
11. The eleventh is the fact that the system is not a simple one, but a complex one, involving many different factors.
12. The twelfth is the fact that the system is not a simple one, but a complex one, involving many different factors.
13. The thirteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
14. The fourteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
15. The fifteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
16. The sixteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
17. The seventeenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
18. The eighteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
19. The nineteenth is the fact that the system is not a simple one, but a complex one, involving many different factors.
20. The twentieth is the fact that the system is not a simple one, but a complex one, involving many different factors.

v = unit shear in concrete, p.s.i.

V = total shear, pounds.

w = equivalent water pressure, pounds per cubic foot.

w_1 = combined dead and live load on dome, kips per square foot.

W_1 = weight of dome, kips.

ϕ_0 = angle subtended by axis of dome and edge of lantern opening, degrees.

ϕ_1 = angle subtended by axis of dome and support edge, degrees.

Δ = deflection, inches.

1. The first thing I noticed when I stepped
 2. out of the car was the smell of the sea.
 3. It was a fresh, salty breeze that
 4. seemed to wash away all my worries.
 5. I walked along the shore, my feet
 6. sinking into the soft sand. The waves
 7. were breaking gently against the rocks,
 8. creating a soothing white foam.
 9. I sat down on a large, flat rock
 10. and watched the sun dip below the horizon.
 11. The sky was a deep, vibrant orange,
 12. reflecting the warm glow of the setting sun.
 13. The water around me shimmered with
 14. golden light, and the air was filled
 15. with the gentle hum of insects.
 16. I felt a sense of peace and tranquility
 17. that I had never experienced before.
 18. The world seemed to slow down, and
 19. all my problems felt distant and
 20. unimportant.

DESIGN DATA

REINFORCED CONCRETE TANK:

- (1) Circular tank resting on ground surface.
- (2) Allowable soil bearing - 3000 psf.
- (3) Allowable stress in circumferential wall steel - 15,000 psi.
(This low allowable stress is chosen to prevent excessive elongation of the steel in case the concrete cracks).
- (4) Allowable stress in all other steel - 18,000 psi.
- (5) f'_c - 3000 psi.
- (6) E_s - 30,000,000 psi.
- (7) Ultimate concrete tensile strength - 250 psi.
- (8) Required tank height (effective) - 20 feet.
- (9) Assume base is fixed.
- (10) Specifications: A.C.I. 318-41 and Br. I.&D. Specs. -31B.
- (11) Unit weight of concrete - 150 pounds per cubic foot.
- (12) Live Load on cover - 25 psf.
- (13) Wind pressure - $5/8 \times 60$ psf of vertical projection.

PRESTRESSED CONCRETE TANK:

- (1) Same diameter and effective height as R.C. tank. Same soil conditions.
- (2) Allowable stress in prestressing steel - 22,500 psi. prior to prestressing.
- (3) Allowable stress in reinforcing steel - 18,000 psi.
- (4) f'_c - 3000 psi.

PRINTED CONDITIONS

- (5) E_c - 30,000,000 psi.
- (6) Ultimate concrete tensile strength - 350 psi.
- (7) Assume base is fixed.
- (8) Unit weight of concrete - 150 pounds per cubic foot.
- (9) Specifications: A.C.I. 318-41
- (10) Live Load on cover - 30 psf.
- (11) Sellar load on dome - 15 kips.
- (12) Wind stress - $2/8 \times 50$ psf of vertical projection

MINIMUM DESIGN

MINIMUMS:

$$\text{Vol.} = 500,000 \text{ gal.} = 64,000 \text{ cu. ft.}$$

$$\text{Diameter} = 64' - 0" \quad \text{Height} = 20'$$

THICKNESS OF WALL:

$$\text{Pressure at bottom of wall} = 62.5 \times 20 = 1250 \text{ p.s.f.}$$

$$\text{Pressure 1 ft. up from bottom} = 62.5 \times 19 = 1187 \text{ p.s.f.}$$

$$\text{Ave. for 1 ft. section} = \frac{1}{2} (1250 + 1187) = 1218 \text{ psf}$$

$$T \text{ for 1 ft. section} = 1218 \times \frac{64}{2} = 39,000^{\#}$$

To allow for shrinkage in the concrete assume coefficient of shrinkage $C = 0.0004$

$$S = \frac{f_c}{n s e C + f_s - f_{em}} =$$

$$= \frac{250}{10(8,000,000) (.0004) + 12000 - 250 \times 10}$$

$$= 0.0116$$

$$t = \frac{T}{12 p f_s} = \frac{39,000}{12 \times .0116 \times 12,000} = 23.4"$$

$$\text{Use } t = 24"$$

$$\text{Let thickness at top} = 8"$$

PROBABILITY

Let X and Y be independent

random variables with the following probability distributions:

$$P(X=x) = \frac{1}{2} \quad \text{for } x = 1, 2$$

$$P(Y=y) = \frac{1}{3} \quad \text{for } y = 1, 2, 3$$

Find the probability

$$P(X+Y=3)$$

$$P(X=1, Y=2) + P(X=2, Y=1)$$

$$= \frac{1}{2} \cdot \frac{1}{3} + \frac{1}{2} \cdot \frac{1}{3}$$

$$= \frac{1}{3}$$

is also the probability of the event $X+Y=3$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

$$P(X+Y=3) = \frac{1}{3}$$

AREA OF STEEL:

Assume concrete cracks and steel takes all of load

$$A_s = \frac{59000}{12000} = 4.92 \text{ sq. in. per ft. of ht.}$$

Per inch of height:

$$A_s = \frac{4.92}{12} = 0.41 \text{ sq. in. per inch.}$$

$$A_s \text{ each side} = \frac{0.41}{2} = 0.205$$

Try $7/8" \phi$

$$\text{Spacing} = \frac{0.6013}{0.205} = 2.93 \text{ USE } 3"$$

Change Steel spacing at 5 ft. intervals.

At 5 ft. above base:

$$T = 62.5 \times 15 \times \frac{64}{2} = 30,000 \text{ \# per ft. of ht.}$$

$$A_s = \frac{30,000}{12,000} = 2.5 \text{ sq. in. per ft.}$$

$$A_s = \frac{2.5}{12} = 0.208 \text{ sq. in. per inch.}$$

$$\text{For two rows } A_s = 0.104 \text{ in. per in.}$$

For $7/8" \phi$

$$\text{Spacing} = \frac{0.6013}{0.104} = 5.78 \text{ USE } 5\frac{1}{2} \text{ inches}$$

At 10 ft. above base

$$T = 62.5 \times 10 \times \frac{64}{2} = 20,000 \text{ \# per ft. of ht.}$$

$$A_s = \frac{20,000}{12,000} = 1.667 \text{ sq. in. per ft.}$$

$$A_s = 0.139 \text{ sq. in. per in.}$$

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

1944-1945

for two rows $\Delta s = 0.0495$ in. per in.

For $7/8 \text{ } \phi$

$$\text{Spacing} = \frac{0.6013}{0.0695} = 8.65 \quad \text{USE } 9\frac{1}{2} \text{ in.}$$

At 15 ft. above base:

$$T = 62.5 \times 5 \times \frac{64}{2} = 10,000 \text{ } \phi$$

$$\Delta_s = \frac{10,000}{12,000} = 0.833 \text{ in. per ft.}$$

$$\Delta s = 0.0695 \text{ inches per in.}$$

For two rows $\Delta s = 0.0343$ in. per in.

For $5/8 \text{ } \phi$

$$\text{Spacing} = \frac{0.31}{0.0343} = 8.9 \text{ in.} \quad \text{USE } 9\frac{1}{2} \text{ in.}$$

For the year 1912 the total was

\$ 1,000.00

For the year 1913 the total was

\$ 1,000.00

For the year 1914 the total was

\$ 1,000.00

For the year 1915 the total was

\$ 1,000.00

\$ 1,000.00

For the year 1916 the total was

\$ 1,000.00

For the year 1917 the total was

\$ 1,000.00

For the year 1918 the total was

For the year 1919 the total was

\$ 1,000.00

For the year 1920 the total was

\$ 1,000.00

For the year 1921 the total was

\$ 1,000.00

MOMENT IN WALL DUE TO FIXED BASE:

$$\begin{aligned}\text{Max. deflection} &= n f_o \frac{\Delta}{2x_o} = \frac{2500 \times 64}{2 \times 30,000,000} \\ &= 0.00267 \text{ ft.} \\ &= 0.032 \text{ in.}\end{aligned}$$

Allowing 2" Cover for steel.

$$A_G = 24 \times 12 = 288 \text{ sq. in.}$$

$$\text{Take } A_S = 0.01 A_G = 0.01 \times 288 = 2.88 \text{ sq. in.}$$

$$t = 24"$$

$$p = 62.5 \times 20 = 1250 \text{ p.s.f.} = 104 \text{ p/in. of ft.}$$

$$I_S = 2.88 \times 10 \times 10 = 288 \text{ inch units}$$

$$I_G = \frac{1}{12} \times 12 \times 24^3 + 9 \times 288 = 13,600 + 2590$$

$$I_G = 16,190 \text{ inch units}$$

Let h_1 = height above base to which cantilever action extends.

$$\text{Deflection} = \frac{1}{80} \frac{(p^1 h_1^4)}{EI}$$

$$\text{or } h_1 = 124.5 (5.05)^{\frac{1}{4}} = 186.5 \text{ in.}$$

$$h_1 = 15.55 \text{ ft.}$$

MOMENT AT BASE:

$$M_1 = \frac{104 \times (186.5)^2}{8} = 451,000 \text{ in p.}$$

$$\text{Taking } d = 20"$$

$$j = 0.857$$

$$k = 0.429$$

$$A_S f_s = P = \frac{451,000}{0.857 \times 20} = 26,400 \text{ p}$$

Assume $f_c = 18,000$ p.s.c.

$$A_g = \frac{25400}{18000} = 1.465 \text{ sq. inches for 1 ft. section.}$$

$$A_s = 0.122 \text{ sq. inches / inch}$$

For $7/8 \phi$

$$\text{Spacing} = \frac{0.6013}{0.122} = 4.93 \text{ USE } 4 \text{ in.}$$

POINT OF CONTRAFLEXURE:

$$\text{Point of C.F.} = 0.37 h_1$$

$$= 0.37 \times 15.53 = 5.75 \text{ ft. up from base.}$$

Extend rods to 7 ft. above base

COMPRESSIVE STRESS IN CONCRETE:

$$f_c = \frac{2M}{k j b d^2} = \frac{2 \times 451,000}{0.429 \times 0.857 \times 12 \times 400}$$

$$= 511 \text{ p.s.c.} \approx \text{Bott}$$

MAXIMUM MOMENT ABOVE POINT OF CF.

$$M = 1/3 M_1$$

$$A_s = 1/3 A_{s1} = \frac{0.122}{3} = 0.041 \text{ sq. inches/inch}$$

for $1/2 \text{ in } \phi$

$$\text{Spacing} = \frac{0.20}{0.041} = 4.88 \text{ USE } 4 \frac{1}{2} \text{ in}$$

EXTEND TO $16 \frac{1}{2}$ Ft. ABOVE BASE.

Extend every fourth rod inside & outside to top for support of circumferential steel and to use as temperature steel.

BEAR AT TOP OF BASE:

$$V = \frac{1250}{2} \times 15.53 = 9700 \text{ #/ft. of width.}$$

$$v = \frac{V}{b j d} = \frac{9700}{12 \times 0.857 \times 20} = 47 \text{ psi.}$$

Allowable = 60 psi

1. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

2. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

3. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

4. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

5. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

6. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

7. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

8. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

9. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

10. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

11. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

12. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

13. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

14. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

15. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

16. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

17. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

18. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

19. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

20. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

21. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

22. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

23. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

DESIGN FOR JOINT:

Assuming simple supports at wall centerline and center of supporting column. USE Span of 32' - 0"

Snow and live load = 25 psf

Wt. of concrete = 150 #/cu. ft.

Total load = 175 #/cu. ft.

$$\text{Reaction @ Wall} = 175 \times \frac{32}{2} \times \frac{2}{3} \times \frac{32}{32} = 1066\frac{2}{3}$$

$$\text{Reaction @ Column} = 175 \times \frac{32}{2} \times \frac{1}{3} \times \frac{32}{32} = 934\frac{2}{3}$$

Maximum moment @ 0.577 L from Small end.

Max. Moment = 0.1283 WL

$$= 0.1283 \times 175 \times \frac{32}{2} \times 32 = 11,500 \text{ Ft. #}$$

WIDTH OF SECTION AT MAX. MOMENT

Section of max. moment = 0.577 x 32 = 18.5' from small end.

$$\text{Width} = \frac{18.5}{32} \times 12 = 6.94"$$

$$f_c = \frac{2M}{kjb d^2}$$

$$d^2 = \frac{2M}{f_c kjb} = \frac{2 \times 11,500 \times 12}{1350 \times 0.429 \times 0.857 \times 6.94}$$

$$d = 9.95" \text{ USED } = 9"$$

USE 3" Cover Total D = 12"

$$A_s = \frac{M}{f_s j d} = \frac{11,500 \times 12}{18,000 \times 0.857 \times 9} = 0.995 \text{ sq. in.}$$

$$A_s / \text{inch} = \frac{0.995}{6.94} = 0.1432 \text{ sq. in.}$$

USE 7/8" ϕ

$$\text{Spacing} = \frac{0.6015}{0.1432} = 4.2 \text{ in. USE } 4.25"$$

Check rebar spacing at wall

$$\frac{18.5}{32} = \frac{4.25}{x} \quad \text{Let } x = \text{spacing @ wall}$$

$$x = \frac{4.25 \times 32}{18.5} = 7.38 \quad \text{Use } 7$$

SHEAR AT WALL:

$$R = 1865 \text{ \#}$$

$$v = \frac{V}{b_j d} = \frac{1865}{12 \times 0.857 \times 9} = 201 \text{ psi.}$$

WALL BEARING CHECK:

$$\text{Bearing} = \frac{1865}{8 \times 12} = 19.4 \text{ psi.}$$

Shear and bearing at column end of cover will be checked after design of column.

DESIGN OF BASE:

Assume:

$$\text{footing width} = 6' - 0"$$

$$\text{Allowable soil bearing pressure} = 3000 \text{ psf.}$$

$$\text{Depth of footing} = 20 \text{ inches.}$$

LOADS:

$$\text{Load on top of wall per foot of wall} = 1865 \text{ \#}$$

$$\text{Wt. of wall per foot} = 4000 \text{ \#}$$

$$\text{Wt. of base} = 1490 \text{ \#}$$

$$\text{Total} \quad \quad \quad \underline{7355 \text{ \#/ft. of wall}}$$

$$\text{Soil bearing due to dead load} = \frac{7355}{6} = 1226 \text{ psf}$$

Given: $\alpha = 0.05$

$$\text{Test Statistic } Z = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} = \frac{1.01 - 1.0}{0.01} = 10$$

$$\text{Critical Value } Z_{\alpha/2} = \frac{Z_{0.025}}{0.01} = 1.96$$

$$\text{Decision: } Z > Z_{\alpha/2}$$

Reject H_0

$$\text{95\% CI} = \frac{1.01 \pm 1.96 \times 0.01}{\sqrt{100}} = 1.0 \pm 0.0196$$

$$\text{CI} = \frac{1.01 \pm 1.96 \times 0.01}{\sqrt{100}} = 1.0 \pm 0.0196$$

$$\text{95\% CI} = \frac{1.01 \pm 1.96 \times 0.01}{\sqrt{100}} = 1.0 \pm 0.0196$$

Since the test statistic is greater than the critical value,

we reject H_0 .

There is a significant difference.

Conclusion: The mean is significantly different from 1.0.

Answer: $\alpha = 0.05$

$$\text{Test Statistic } Z = 10$$

Decision: Reject H_0

Conclusion: The mean is significantly different from 1.0.

100%

Since the test statistic is greater than the critical value,

we reject H_0 .

There is a significant difference.

Conclusion: The mean is significantly different from 1.0.

$$\text{95\% CI} = \frac{1.01 \pm 1.96 \times 0.01}{\sqrt{100}} = 1.0 \pm 0.0196$$

Total load due to water on base:

$$\pi \times 32 \times 32 \times 1250 = 4,020,000 \text{ \#}$$

Area of base:

$$\pi \times 36 \times 36 = 4070 \text{ sq. ft.}$$

Soil bearing due to water:

$$\frac{4,020,000}{4070} = 987 \text{ psf}$$

Total soil bearing pressure at foot of wall:

$$987 + 1226 = 2213 \text{ psf.}$$

3000 psf allowed.

Considering the part of the foundation that extends beyond the wall to act as a cantilever and taking moments about the face of the wall we have -

$$M = 12 \times (2213) \times 6 = 53,100 \text{ in. lbs.}$$

$$A_s = \frac{M}{f_{sy}d} = \frac{53,100}{18000 \times 0.857 \times 17}$$

$$A_s = 0.202 \text{ sq. in. per foot}$$

Using $\frac{1}{4}$ " ϕ Area = 0.20

$$\text{Spacing} = \frac{0.20}{0.202} = .99 \text{ ft.}$$

USE 12" Spacing for $1/2$ " ϕ

SHEAR CHECK AT FACE OF WALL:

$$v = \frac{4420}{12 \times 0.857 \times 17} = 25.3 \text{ psi}$$

Allowable = 60 psi.

CHECK FOR WIND LOAD:

Assume 50 #/ sq. ft.

total cost due to entry on same;

It is also to be noted that

the cost of entry is

It is also to be noted that

the cost of entry is

$\frac{1,000,000}{100} = 10,000$

Total cost of entry is

10,000

10,000

Consequently the cost of the transaction is

the cost of entry is

10,000

$10,000 \times 10 = 100,000$

$\frac{100,000}{100} = 1,000$

$1,000 \times 10 = 10,000$

10,000

$\frac{10,000}{100} = 100$

100

100

$\frac{100}{100} = 1$

1

1

1

$$\text{Load} = 5/8 \times 50 \times 64 = 2000 \text{ \# /ft. of ft.}$$

$$\text{Total} = 20 \times 2000 = 40,000 \text{ \#}$$

$$\text{Mom.} = 40000 \times 10 = 4000,000 \text{ Ft. \#}$$

MOMENT OF INERTIA OF CROSS SECTION:

$$I = \frac{\pi}{4} \left(\frac{4}{33.33}^4 - \frac{4}{32}^4 \right) = 145,000 \frac{\text{in}^4}{\text{ft.}}$$

STRESS DUE TO LIVE LOAD:

$$f = \frac{MC}{I} = \frac{400,000 \times 33.33}{145,000} = 91.5 \text{ \# /ft. of wall}$$

This additional loading would not change dimensions of footing.

COLUMN DESIGN:

$$\text{Roof slab reaction on column} = 188,000 \text{ \#}$$

Estimated weights:

$$\text{Capital} = 4530 \text{ \#}$$

$$\text{Drop panel} = 3200 \text{ \#}$$

$$\text{Column} = 5560 \text{ \#}$$

$$\text{Total} = 13,290$$

$$\begin{aligned} \text{Therefore load on base slab} &= 13,290 + 188,000 \\ &= 201,290 \end{aligned}$$

For 20" column;

$$\text{Load on concrete} = 212,000 \text{ \# from ACI Design Hand book}$$

$$\text{Theoretical load on the steel} = 0$$

Use 3/8" hoops on 12" Centers and

$$\text{Vertical Steel} = 6 - 5/8 \text{ \#}$$

$$1000 \times 10^3 \times 10^3 = 1000 \times 10^6 = 10^9$$

$$1000 \times 10^3 = 10^6$$

$$1000 \times 10^3 = 10^6$$

1000 x 10^3 = 10^6

$$\frac{1}{1000} \times 10^6 = \frac{1}{1000} \times 10^6 = 10^3$$

1000 x 10^3 = 10^6

$$1000 \times 10^3 = 10^6$$

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

1000 x 10^3 = 10^6

Size of column and steel, though not required to carry load were chosen to lend rigidity which is the important factor.

Soil bearing at base of column.

Use 10' -0" Dia. base slab.

Area = 78.6 sq. ft.

Wt. of Base $78.6 \times 1 \times 150 = 11,800 \text{ \#}$

Total wt. on soil = $11,800 + 201,290 = 213,090$

Stress = $\frac{213,090}{78.6} = 2,710 \text{ p.s.f.}$

CHECK AT POINT AND BEARING IN TERMS OF COLUMN CAPITAL:

Assume bearing at 2 ft. from center of column.

Bearing area = 11.25 sq. in.

Reaction on column = 934 \#

Bearing pressure = $\frac{934}{11.25} = 83.4 \text{ psi}$

SHEAR CHECK:

At a distance $d = t - 1\frac{1}{2}$ from edge of column. Capital $b = 1.45'$

$d = 10.5'$

$v = \frac{V}{bjd} = \frac{934}{1.45 \times 0.657 \times 10.5} = 71.5 \text{ psi.}$

Allowable = 90 psi.

DESIGN OF FLOOR SLAB:

Except for the cantilever section of the base no moment occurs in the base slab. Assuming uniform settlement of the soil. Therefore the slab will not be designed to resist moment. However, to assume the settlement over the entire area to be uniform might lead to

also be subject to the same conditions as the other two.

It is also subject to the same conditions as the other two.

The first of these conditions is that the

second of these conditions is that the

third of these conditions is that the

fourth of these conditions is that the

fifth of these conditions is that the

and

It is also subject to the same conditions as the other two.

The first of these conditions is that the

second of these conditions is that the

third of these conditions is that the

fourth of these conditions is that the

and

It is also subject to the same conditions as the other two.

The first of these conditions is that the

second of these conditions is that the

third of these conditions is that the

fourth of these conditions is that the

fifth of these conditions is that the

It is also subject to the same conditions as the other two.

The first of these conditions is that the

second of these conditions is that the

third of these conditions is that the

fourth of these conditions is that the

DRAWING OF BASE SLAB - Continued :

dangerous cracking of the floor of the tank. To prevent this a relatively thin slab will be laid. The flexibility of the thin slab will be such that it can conform to any slight differential settlement without producing cracks.

(See drawing for dimensions and steel in base slab)

Also all of them that is one hundred in my right hand.

1. The Commission has received information from the
2. Ministry of Health, that the following persons have
3. been identified as having been in contact with the
4. patient during the period of the outbreak.

ATTACHED FILE(S)

THE UNIVERSITY OF CHICAGO PRESS

Pressure at bottom of wall

$$2 \text{ in. WTR} = 62.5 \times 20 \times 32 = 40,000 \text{ #/ft.}$$

Assuming the concrete to take zero stress when Tank is full:

$$A_8 = \frac{P}{S_8} = \frac{40,000}{22,500} = 1.78 \text{ sq. in./ft.}$$

(See Fig. 1 for steel spacings)

Adding 1 foot at bottom of tank for construction joint and using

4 bands @ 3" spacing, total number of bands used will be 41 3/4" p.

THEIR OWNERS

$$F_{01} = \frac{F_0 + 1}{1 + n_p} \cdot \frac{22,500 + 0.0002 \times 50 \times 10,000,000}{1.14}$$

25,000 psi allowable initial steel prestress.

1990年12月

Current practice limits percentage of steel in bands to 2% of concrete area; hence

$$t = \frac{1.70}{0.02 \times 12} = 7.34'' \quad \text{U.L.T. 8''}$$

Max. percentage of steel = $\frac{1.76}{8 \times 12} = .01833$

Copyright © 1999 by John Wiley & Sons, Inc.

Since Col = - p_{col}.

Pol = $-.01855 \times 35,000 = 458$ psi Allowable = 1350 psi

Minimum steel percentage at top or wall

$$\frac{0.33}{8 \times 12} = 0.00344 \text{ Therefore}$$

$$\sigma_{ol} \text{ (Min)} = -00344 \times 25,000 = 88 \text{ psi.}$$

PROBLEM 1

SOLUTION

Let x be the number of units produced.

$$y = 100x - 0.001x^2 \quad \text{Revenue}$$

Let C be the total cost of production.

$$C = 1000 + 0.001x^2 \quad \text{Cost}$$

Profit is given by

$P = R - C = 100x - 0.001x^2 - (1000 + 0.001x^2)$

$P = 100x - 0.002x^2 - 1000$

PROBLEM 2

$$y = 100x - 0.001x^2 \quad \text{Revenue}$$

$$C = 1000 + 0.001x^2 \quad \text{Cost}$$

SOLUTION

Let x be the number of units produced.

Revenue

$$y = 100x - 0.001x^2$$

$$C = 1000 + 0.001x^2$$

PROBLEM 3

Let x be the number of units produced.

$$y = 100x - 0.001x^2 \quad \text{Revenue}$$

Let C be the total cost of production.

$$C = 1000 + 0.001x^2 \quad \text{Cost}$$

$$P = R - C = 100x - 0.002x^2 - 1000$$

TENSION BAND LENGTH:

Radius to center line of bands

$$\text{Radius} = 32 + \frac{2 + .375}{12} = 32.692 \text{ ft.}$$

$$\text{Circumference} = 2\pi \times 32.692 = 206.0 \text{ ft.}$$

USE 4 bars per band length 51.5' per bar.

$$\text{Total number of bars} = 4 \times 41 = 164 = 51.5' \text{ and } 164 \text{ turn buckles}$$

CHECK FOR TENSILE STRESS W/IN TO PRESTRESSING BANDS:

When the bottom bands are prestressed to a ring tension of

$$1.76 \times 25,000 = 44,000 \text{ \#/ft.}$$

they will exert a radial pressure on the wall equal to their ring tension divided by their radius,

$$\frac{44,000}{32.69} = 1347 \text{ \#/ft.}$$

This corresponds to a water pressure of

$$\frac{1347}{20} = 67.3 \text{ \#/ft.}$$

Using moment coefficient tables given in "MODERN DEVELOPMENTS IN REINFORCED CONCRETE".

Entering table with:

$$\frac{h^2}{Dt} = \frac{20 \times 20}{64 \times 0.667} = 9.36$$

$$\text{And } WR^3 = 67.3 \times \frac{20^3}{20} = 538,000 \text{ ft. \#/ft.}$$

Point	0.0H	0.1H	0.2H	0.3H	0.4H	0.5H	0.6H	0.7H	0.8H	0.9H	1.0H
Coeff.											
from	0.0	0.0	0.0	-.00002	-.00001	.00004	.00014	.00029	.00047	.00049	0
Table											
VIII											
Moment	0	0	0	-107.6	-55.8	124.5	154	1560	2530	2640	0

Section 1.000.000.000

$$1.000.000.000 = 1.000.000.000 \times 1.000.000.000$$

$$1.000.000.000 = 1.000.000.000 \times 1.000.000.000$$

$$1.000.000.000 = 1.000.000.000 \times 1.000.000.000$$

$$1.000.000.000 = 1.000.000.000 \times 1.000.000.000$$

SECTION 1.000.000.000.000

Section 1.000.000.000.000.000

$$1.000.000.000.000.000 = 1.000.000.000.000.000 \times 1.000.000.000.000.000$$

Section 1.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000

$$1.000.000.000.000.000.000.000 = 1.000.000.000.000.000.000.000 \times 1.000.000.000.000.000.000.000$$

Section 1.000.000.000.000.000.000.000.000

$$1.000.000.000.000.000.000.000.000 = 1.000.000.000.000.000.000.000.000 \times 1.000.000.000.000.000.000.000.000$$

Section 1.000.000.000.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000.000.000.000.000

$$1.000.000.000.000.000.000.000.000.000.000.000 = 1.000.000.000.000.000.000.000.000.000.000.000 \times 1.000.000.000.000.000.000.000.000.000.000.000.000$$

$$1.000.000.000.000.000.000.000.000.000.000.000.000 = 1.000.000.000.000.000.000.000.000.000.000.000.000 \times 1.000.000.000.000.000.000.000.000.000.000.000.000.000$$

Section 1.000.000.000.000.000.000.000.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000.000.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000.000.000.000.000.000.000.000.000

Section 1.000.000.000.000.000.000.000.000.000.000.000.000.000.000.000.000

See Moment curve fig. 3. (appended)

From Moment diagram max. moment is,

2650 ft. # @ 17.5' from top.

Vertical steel necessary to resist moment

$$A_s = \frac{M}{f_s j d} = \frac{2650 \times 12}{18000 \times 0.857 \times 6} = .344 \text{ sq. in./ft.}$$

USE 1/2" # @ 7" spacing.

Compressive concrete stress due to moment,

$$f_c = \frac{2650 \times 12 \times 4}{\frac{1}{12} \times 12 \times \frac{4}{3}} = 244 \text{ p.s.i.} \quad \text{Allowable} - 250 \text{ p.s.i.}$$

DESIGN OF WALL FOOTING

Load on top of wall per ft.	=	1890 [#]
Wt. of wall per ft.	=	2100 [#]
Assumed depth of footing 12" wt.	=	600 [#]
Total		<u>4290[#]</u>

Assume width of footing = 4' -0"

Soil bearing = $\frac{4290}{4} = 1071 \text{ p.s.f.}$

Total load due to water = 4,020,000[#]

Area of base 3420 sq. ft.

Soil bearing due to water = $\frac{4,020,000}{3420} = 1175 \text{ p.s.f.}$

Total soil bearing = 1071 + 1175 = 2246 p.s.f.

Allowable 3000 p.s.f.

Using a footing section as shown in drawing of prestressed tank
critical moment will occur in section marked (a)

two hundred square feet (approx.)

These figures are based on

data for a 10' x 10' area

Portion of area necessary to install system

$$A = \frac{1}{2} \times \frac{1000 \times 10}{1000 \times 0.007 \times 0.007} = 1000 \text{ sq. ft.}$$

Use 1/2" x 7" rods.

Compressive strength of concrete

$$f_c = \frac{1000 \times 10 \times 0.007}{1000 \times 0.007 \times 0.007} = 1000 \text{ psi}$$

TABLE OF DATA

1000	=	Area of wall per foot
1000	=	Area of wall per foot
1000	=	Area of wall per foot
1000	=	Area of wall per foot
1000	=	Area of wall per foot

Area of wall per foot = 1000

$$\text{Total area} = 1000 \times 10 = 10000 \text{ sq. ft.}$$

Total load on column = 400,000

Area of column = 100 sq. ft.

Load per square foot = 4000

Total wall loading = 1000 x 10 = 10000

Area of wall = 10000

Using a column section as shown in drawing at top of page

Required moment will occur in middle of column

Moment at point (a)

$$M = 3690 \times 4 = 14,760 \text{ in.}^2$$

Check for f_c .

$$f_c = \frac{2 \times 14,760}{0.429 \times 0.857 \times 10 \times 10 \times 12} = 65 \text{ psi}$$

$$\text{Allowable} = 250 \text{ psi.}$$

$$A_s = \frac{M}{f_{sjd}} = \frac{14,760}{18,000 \times .857 \times 10} = .096 \text{ sq. in./ft.}$$

Using $1/2'' \phi$ Area 0.30

$$\text{Spacing} = \frac{0.20}{.096} = 2.09 \text{ ft. USE } 12''$$

Check Shear at critical Section.

$$V = \frac{V}{bjd} = \frac{3690}{12 \times 0.857 \times 10} = 36.0 \text{ psi}$$

WIND STRESS:

Moment = 400,000 ft. # (from previous design)

$$I = \frac{\pi}{4} \left(\frac{32.67^4}{4} - \frac{32^4}{4} \right) = 47,200 \text{ ft. units}$$

$$f = \frac{400,000 \times 32.67}{47,200} = 277 \text{ #/ft. of wall}$$

Total soil bearing = 2525 p.s.f.

Therefore wind stress does not change dimensions of footing.

Amount of Part (a) = 10,000

10,000 x 0.05 = 500

Amount for Part

$$10,000 \times 0.05 = 500$$

Amount = 500

$$10,000 \times 0.05 = 500$$

Value of Part = 500

Amount = 500

Amount of Part (a) = 10,000

$$10,000 \times 0.05 = 500$$

Amount

Amount = 500

$$10,000 \times 0.05 = 500$$

$$10,000 \times 0.05 = 500$$

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

Amount of Part (a) = 10,000

DOM: DESIGN FOR COMPRESSION RING:

Refer to Figure 4 for general information.

Radius of sphere:

$$r^2 = 32 \times 32 + (r - 6)^2$$

$$r = 67.8 \text{ ft.}$$

Assume 5" thickness:

$$w_1 = 0.0625 + 0.030 = 0.0925 \text{ kips/sq. ft.}$$

$$\sin \phi_0 = \frac{5}{67.8} = 0.0442; \cos \phi_0 = 0.996$$

$$\sin \phi_1 = \frac{32}{67.8} = 0.472; \sin^2 \phi_1 = 0.222$$

$$\cos \phi_1 = 0.882$$

$$\phi_1 = 28^\circ$$

$$W_1 = 2 \pi \times 67.8 \times 67.8 \times 0.0925 (0.996 - 0.882)$$

$$= 320 \text{ kips.}$$

$$T_1 = \frac{320}{2 \pi \times 67.8 \times 0.222} = 3.39 \text{ kips/ ft.}$$

$$= \frac{3390}{5 \times 12} = 56.5 \text{ p.s.i.}$$

$$H_1 = -3.39 + 0.0925 \times 67.8 \times 0.882 = 2.11 \text{ kips/ ft.}$$

$$= 35.2 \text{ p.s.i.}$$

$$S_1 = \frac{320 \times 0.882}{2 \pi \times 0.471} = 95.5 \text{ kips. ring tension in edge member.}$$

$$S_0 = \frac{15 \times 0.996}{2 \pi \times 0.0442} = 53.7 \text{ kips compression in edge member}$$

of lantern.

EDGE MEMBER FOR DOM:

$$\text{Bearing on wall} = \frac{320,000}{201.5 \times 12 \times 8} = 16.6 \text{ p.s.i.}$$

Allowable = 750 p.s.i. in bearing.

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE ASSISTANT SECRETARY FOR TECHNICAL ASSISTANCE

REPORT ON THE

$$F_1 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_2 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

AND THE

$$F_3 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_4 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_5 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_6 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_7 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_8 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_9 = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{10} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{11} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{12} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{13} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{14} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{15} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

$$F_{16} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

UNITED STATES DEPARTMENT OF AGRICULTURE

$$F_{17} = 0.5 + 0.5 \cdot (1 - 0.5)^n$$

UNITED STATES DEPARTMENT OF AGRICULTURE

Ring tension $\frac{1}{2}$ 95.5 kips; $A_s = \frac{95.5}{20} = 4.76$ sq. in. USE 6 - 1" ϕ .

Shear on 5" section; $v = \frac{320,000}{201.5 \times 12 \times 5} = 26.6$ p.s.i. (O.K.)

Temperature steel - Use 1/4" ϕ @ 12" both ways.

LARKIN COLUMN:

Compression in edge member = 53.7 kips

Allowable on concrete = 1360 p.s.i.

$A = \frac{53,700}{1360} = 39.5$ sq. in.

Use 6" x 7" coping.

$\lambda_1 = 1$ and $\lambda_2 = 2$ (see [10]). Let \mathcal{H}_1 and \mathcal{H}_2 be Hilbert spaces and let $\mathcal{H} = \mathcal{H}_1 \oplus \mathcal{H}_2$ be their direct sum. Let \mathcal{H}_1 and \mathcal{H}_2 be equipped with the inner products $\langle \cdot, \cdot \rangle_1$ and $\langle \cdot, \cdot \rangle_2$ respectively. Let \mathcal{H} be equipped with the inner product $\langle \cdot, \cdot \rangle$ defined by

(b) $\lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n f\left(\frac{k}{n}\right) = \int_0^1 f(x) dx$ if f is continuous on $[0, 1]$.

1951-1952 1953-1954 1955-1956 1957-1958 1959-1960 1961-1962 1963-1964 1965-1966 1967-1968 1969-1970 1971-1972 1973-1974 1975-1976 1977-1978 1979-1980 1981-1982 1983-1984 1985-1986 1987-1988 1989-1990 1991-1992 1993-1994 1995-1996 1997-1998 1999-2000 2001-2002 2003-2004 2005-2006 2007-2008 2009-2010 2011-2012 2013-2014 2015-2016 2017-2018 2019-2020 2021-2022 2023-2024 2025-2026 2027-2028 2029-2030 2031-2032 2033-2034 2035-2036 2037-2038 2039-2040 2041-2042 2043-2044 2045-2046 2047-2048 2049-2050 2051-2052 2053-2054 2055-2056 2057-2058 2059-2060 2061-2062 2063-2064 2065-2066 2067-2068 2069-2070 2071-2072 2073-2074 2075-2076 2077-2078 2079-2080 2081-2082 2083-2084 2085-2086 2087-2088 2089-2090 2091-2092 2093-2094 2095-2096 2097-2098 2099-2100 2101-2102 2103-2104 2105-2106 2107-2108 2109-2110 2111-2112 2113-2114 2115-2116 2117-2118 2119-2120 2121-2122 2123-2124 2125-2126 2127-2128 2129-2130 2131-2132 2133-2134 2135-2136 2137-2138 2139-2140 2141-2142 2143-2144 2145-2146 2147-2148 2149-2150 2151-2152 2153-2154 2155-2156 2157-2158 2159-2160 2161-2162 2163-2164 2165-2166 2167-2168 2169-2170 2171-2172 2173-2174 2175-2176 2177-2178 2179-2180 2181-2182 2183-2184 2185-2186 2187-2188 2189-2190 2191-2192 2193-2194 2195-2196 2197-2198 2199-2200 2201-2202 2203-2204 2205-2206 2207-2208 2209-2210 2211-2212 2213-2214 2215-2216 2217-2218 2219-2220 2221-2222 2223-2224 2225-2226 2227-2228 2229-2230 2231-2232 2233-2234 2235-2236 2237-2238 2239-2240 2241-2242 2243-2244 2245-2246 2247-2248 2249-2250 2251-2252 2253-2254 2255-2256 2257-2258 2259-2260 2261-2262 2263-2264 2265-2266 2267-2268 2269-2270 2271-2272 2273-2274 2275-2276 2277-2278 2279-2280 2281-2282 2283-2284 2285-2286 2287-2288 2289-2290 2291-2292 2293-2294 2295-2296 2297-2298 2299-2300 2301-2302 2303-2304 2305-2306 2307-2308 2309-2310 2311-2312 2313-2314 2315-2316 2317-2318 2319-2320 2321-2322 2323-2324 2325-2326 2327-2328 2329-2330 2331-2332 2333-2334 2335-2336 2337-2338 2339-2340 2341-2342 2343-2344 2345-2346 2347-2348 2349-2350 2351-2352 2353-2354 2355-2356 2357-2358 2359-2360 2361-2362 2363-2364 2365-2366 2367-2368 2369-2370 2371-2372 2373-2374 2375-2376 2377-2378 2379-2380 2381-2382 2383-2384 2385-2386 2387-2388 2389-2390 2391-2392 2393-2394 2395-2396 2397-2398 2399-2400 2401-2402 2403-2404 2405-2406 2407-2408 2409-2410 2411-2412 2413-2414 2415-2416 2417-2418 2419-2420 2421-2422 2423-2424 2425-2426 2427-2428 2429-2430 2431-2432 2433-2434 2435-2436 2437-2438 2439-2440 2441-2442 2443-2444 2445-2446 2447-2448 2449-2450 2451-2452 2453-2454 2455-2456 2457-2458 2459-2460 2461-2462 2463-2464 2465-2466 2467-2468 2469-2470 2471-2472 2473-2474 2475-2476 2477-2478 2479-2480 2481-2482 2483-2484 2485-2486 2487-2488 2489-2490 2491-2492 2493-2494 2495-2496 2497-2498 2499-2500 2501-2502 2503-2504 2505-2506 2507-2508 2509-2510 2511-2512 2513-2514 2515-2516 2517-2518 2519-2520 2521-2522 2523-2524 2525-2526 2527-2528 2529-2530 2531-2532 2533-2534 2535-2536 2537-2538 2539-2540 2541-2542 2543-2544 2545-2546 2547-2548 2549-2550 2551-2552 2553-2554 2555-2556 2557-2558 2559-2560 2561-2562 2563-2564 2565-2566 2567-2568 2569-2570 2571-2572 2573-2574 2575-2576 2577-2578 2579-2580 2581-2582 2583-2584 2585-2586 2587-2588 2589-2590 2591-2592 2593-2594 2595-2596 2597-2598 2599-2600 2601-2602 2603-2604 2605-2606 2607-2608 2609-2610 2611-2612 2613-2614 2615-2616 2617-2618 2619-2620 2621-2622 2623-2624 2625-2626 2627-2628 2629-2630 2631-2632 2633-2634 2635-2636 2637-2638 2639-2640 2641-2642 2643-2644 2645-2646 2647-2648 2649-2650 2651-2652 2653-2654 2655-2656 2657-2658 2659-2660 2661-2662 2663-2664 2665-2666 2667-2668 2669-2670 2671-2672 2673-2674 2675-2676 2677-2678 2679-2680 2681-2682 2683-2684 2685-2686 2687-2688 2689-2690 2691-2692 2693-2694 2695-2696 2697-2698 2699-2700 2701-2702 2703-2704 2705-2706 2707-2708 2709-2710 2711-2712 2713-2714 2715-2716 2717-2718 2719-2720 2721-2722 2723-2724 2725-2726 2727-2728 2729-2730 2731-2732 2733-2734 2735-2736 2737-2738 2739-2740 2741-2742 2743-2744 2745-2746 2747-2748 2749-2750 2751-2752 2753-2754 2755-2756 2757-2758 2759-2760 2761-2762 2763-2764 2765-2766 2767-2768 2769

COMPARISON OF RELATIVE COSTS

As previously stated the comparison of the preceding designs will be based solely upon the quantity of materials (steel and concrete) used in each case, no attempt being made to evaluate fabrication costs and labor charges due to the many variable and unknown factors affecting the latter costs.

The total quantity of steel rods required in the case of the reinforced concrete tank is 82,277 pounds, and the corresponding total volume of concrete is 446 cubic yards. In the case of the prestressed concrete tank the total quantity of steel rods required is 27,734 pounds and the total volume of concrete is 318 cubic yards.

For these figures the difference in quantity of materials and the per cent saving gained by using prestressed construction are as follows:

	<u>R.C. Design</u>	<u>Prestressed Design</u>	<u>Difference</u>	<u>% Savings</u>
Total Steel	82,277#	27,734#	54,543#	66.3%
Total Concrete	446 cu. yd.	318 cu. yd.	128 cu. yd.	29.6%

These figures include the additional saving gained by using the dome cover with the prestressed construction in preference to the flat slab cover of the reinforced concrete construction. The quantities of materials required for these covers alone (but including the center supporting column in the case of the flat slab) are:

	<u>R.C. Design</u>	<u>Prestressed Design</u>	<u>Difference</u>	<u>% Savings</u>
Total Steel	19,020 #	1,110 #	17,910 #	94%
Total Concrete	129 cu. yd.	51 cu. yd.	78 cu. yd.	60.5%

1. The first step in the process of identifying a problem is to determine whether a problem exists. This is often done by comparing current performance with a desired or expected performance level. If there is a significant difference, a problem is identified.

1. The first step in the process of identifying a problem is to define the problem. This involves identifying the symptoms of the problem and determining the scope of the problem. Once the problem has been defined, the next step is to identify the causes of the problem. This involves identifying the factors that are contributing to the problem and determining the underlying causes. Once the causes have been identified, the next step is to develop a plan of action. This involves identifying the steps that need to be taken to solve the problem and determining the resources that will be needed to implement the plan. Finally, the last step in the process is to implement the plan and monitor the results. This involves putting the plan into action and tracking the progress of the solution. Once the problem has been solved, the final step is to evaluate the results and determine if the solution was effective. This involves comparing the results of the solution to the original problem and determining if the problem has been solved.

THE NEW YORK PUBLIC LIBRARY
ASTOR LENOX TILDEN FOUNDATION
455 FIFTH AVENUE
NEW YORK 17, N.Y.

Account	Debit	Credit	Balance
101 Cash	100.00		100.00
102 Accounts Receivable		100.00	100.00
103 Inventory		100.00	100.00
104 Prepaid Insurance		100.00	100.00
105 Equipment		100.00	100.00
106 Accumulated Depreciation			
201 Accounts Payable		100.00	100.00
202 Long-Term Debt		100.00	100.00
203 Equity		100.00	100.00
301 Sales		100.00	100.00
302 Cost of Sales	100.00		100.00
303 Selling Expenses		100.00	100.00
304 Administrative Expenses		100.00	100.00
305 Depreciation Expense		100.00	100.00
306 Interest Expense		100.00	100.00
307 Income Tax Expense		100.00	100.00
308 Retained Earnings		100.00	100.00
309 Dividends	100.00		100.00

There is no other way to achieve the same result as the one achieved by the use of the word "and" in the above sentence. The word "and" is used to connect two or more things, and it is the only way to do so in English. The word "and" is used to connect two or more things, and it is the only way to do so in English.

Then, assuming the same cover (flat slab) in both designs, the quantity of materials in each case would represent a true comparison of the relative economy of materials for the two types of construction. These figures are:

	<u>R.C. Design</u>	<u>Prestressed Design</u>	<u>Difference</u>	<u>Savings</u>
Total Steel	82,377 #	45,644 #	36,633 #	44.5%
Total Concrete	446 cu. yd.	396 cu. yd.	50 cu. yd.	11.2%

These members are not only (1) to be in the
 position of affairs in each case with reference to the
 of the affairs of the country in the year of the
 the year of the year.

The following members are			
1871	1872	1873	1874
1875	1876	1877	1878

The following members are
 the following members are
 the following members are
 the following members are
 the following members are

The following members are
 the following members are
 the following members are

The following members are			
1879	1880	1881	1882
1883	1884	1885	1886

The following members are
 the following members are
 the following members are
 the following members are
 the following members are

The following members are			
1887	1888	1889	1890
1891	1892	1893	1894

CONCLUSION

An indication of the advantages to be gained by using prestressed concrete construction is given by the figures representing the quantity of materials required for this type of construction compared to the quantity required for conventional construction. It is realized that a comparison made solely on this basis is not indicative of the overall costs in each case, but a complete study of this matter is beyond the scope of this thesis as actual construction costs were not available to the authors.

On the other hand, the figures presented for comparison do not reveal all of the advantages gained by using prestressed construction in this case. For the prestressed tank cracklessness is guaranteed and this quality is, of course, of primary importance in a pressure vessel. To obtain a comparable degree of security in this respect in the case of the reinforced concrete tank it was considered advisable to reduce the allowable tensile stress in the circumferential steel to 12,000 p.s.i. or about 67 per cent of the usual value for tensile reinforcement. For the corresponding steel in the prestressed tank it was possible to utilize the full allowable stress, higher strength steel being used economically in this case.

It should also be pointed out that the lower total weight of the structure and hence the lower soil bearing pressures (for the same size footings) might be the controlling factor in a location of low soil bearing.

Introduction

The purpose of this report is to provide a comprehensive overview of the current state of the research in the field of artificial intelligence. The report is organized into several sections, each focusing on a different aspect of the field. The first section discusses the history and development of artificial intelligence, while the second section focuses on the current state of the field. The third section discusses the challenges and opportunities in the field, and the fourth section discusses the future of the field. The report is intended to provide a high-level overview of the field for those who are interested in the topic.

In the first section, the history of artificial intelligence is discussed. The report begins by discussing the early work in the field, which was primarily focused on the development of algorithms for solving problems. This work was followed by a period of relative inactivity, during which the field was largely ignored. However, in the 1950s, there was a resurgence of interest in the field, and a number of important advances were made. These advances included the development of the first artificial neural networks, the development of the first expert systems, and the development of the first natural language processing systems. The report then discusses the current state of the field, which is characterized by a rapid pace of research and development. This is due to a number of factors, including the availability of large amounts of data, the development of powerful new algorithms, and the increasing interest in the field by both the academic and industrial communities. The report then discusses the challenges and opportunities in the field, and the future of the field.

The second section of the report discusses the current state of the field. It begins by discussing the progress that has been made in the field of artificial neural networks. This progress has been largely due to the development of deep learning algorithms, which have enabled researchers to achieve state-of-the-art results in a number of tasks, including image recognition, speech recognition, and machine translation. The report then discusses the progress that has been made in the field of expert systems. This progress has been largely due to the development of new algorithms for solving complex problems, and the increasing availability of data. The report then discusses the progress that has been made in the field of natural language processing. This progress has been largely due to the development of new algorithms for understanding the meaning of text, and the increasing availability of data.

The free base which is well suited to the prestressed construction obviates the necessity of providing for moment in the circumferential footing at the base of the wall.

These factors would, in some cases, counter-balance the additional cost of construction for a prestressed tank and thus lend more reality to the figures presented for comparison.

In the process of design of the prestressed tank the authors attempted to design a flat slab cover using prestressed beam theory but this was found to be impractical from a construction standpoint due to the requirement of a constant percentage of steel throughout the cover to maintain economy of design. The difficulty encountered in carrying out this requirement would present itself in the fabrication stage. It appears to be impractical to cut off any of the rods at the interior of the span of the slab, to anchor these rods at the interior point, and to apply the necessary force for prestressing either before or after setting of the concrete. Further study of this subject will be required to devise a means of overcoming these difficulties in order that the prestressing theories may be applied to members whose cross sectional area varies with length.

THE FIRST PART OF THE REPORT IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

THE SECOND PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR. THE THIRD PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

THE FOURTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR. THE FIFTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

THE SIXTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR. THE SEVENTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

THE EIGHTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR. THE NINTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

THE TENTH PART IS A SUMMARY OF THE WORK DONE DURING THE YEAR.

BIBLIOGRAPHY

- John Edward Kirkman, "Reinforced Concrete", First Edition, McGraw Bros.
- Clarence W. Dunham, "The Theory and Practice of Reinforced Concrete",
Second Edition, Mc-Graw Hill.
- Paul W. Abeles, "Fully and Partly Prestressed Concrete", A.C.I. Journal,
June, 1945.
- John L. Mason, "Prestressed Circular Tanks", Modern Developments in
Reinforced Concrete No. 3.
- "Circular Concrete Tanks Without Prestressing", Modern Developments in
Reinforced Concrete No. 4.
- Herman Schorer, "Prestressed concrete Design Principles and Reinforcing
Units", A.C.I. Journal, June, 1943.
- Herman Schorer, "Saving Steel in Reinforced Concrete", A.C.I. Journal,
June, 1943.
- W.B. Hewett, "A New Method of Constructing Reinforced Concrete Tanks",
A.C.I. Proceedings, 1933.
- R. H. Evans and G. Wilson, "Influence of Prestressing Reinforced Concrete
Beams on Their Resistance to Shear", Structural Engineering, August,
1942.
- S. Timoshenko, "Strength of Materials", Part II, Macmillan Co.
- C. E. Ross, "Test of Prestressed Concrete Pipes Containing a Steel Cylinder".
- H. A. Stanley and D. Peabody Jr., "Shrinkage and Plastic Flow of Prestressed
Concrete", A.C.I. Journal, December, 1946.
- H. A. Spaner, "Navy Installations of Protective Linings for Prestressed
Concrete Tanks Containing Liquid Fuels", A.C.I. Journal, April, 1946.

APPENDIX

THE HISTORY OF THE UNITED STATES OF AMERICA

FROM THE FIRST SETTLEMENTS TO THE PRESENT TIME

BY JAMES OSGOOD, ESQ.

NEW YORK: 1851.

Published by J. Osgood, No. 21, NASSAU ST.

1851.

Vol. I. PART I. THE FIRST SETTLEMENTS.

CHAPTER I. THE FIRST SETTLEMENTS.

SECTION I. THE FIRST SETTLEMENTS.

SECTION II. THE FIRST SETTLEMENTS.

SECTION III. THE FIRST SETTLEMENTS.

SECTION IV. THE FIRST SETTLEMENTS.

SECTION V. THE FIRST SETTLEMENTS.

SECTION VI. THE FIRST SETTLEMENTS.

1851.

SECTION VII. THE FIRST SETTLEMENTS.

SECTION VIII. THE FIRST SETTLEMENTS.

SECTION IX. THE FIRST SETTLEMENTS.

SECTION X. THE FIRST SETTLEMENTS.

SECTION XI. THE FIRST SETTLEMENTS.

SECTION XII. THE FIRST SETTLEMENTS.

SECTION XIII. THE FIRST SETTLEMENTS.

SECTION XIV. THE FIRST SETTLEMENTS.

SECTION XV. THE FIRST SETTLEMENTS.

SECTION XVI. THE FIRST SETTLEMENTS.

SECTION XVII. THE FIRST SETTLEMENTS.

SECTION XVIII. THE FIRST SETTLEMENTS.

BIBLIOGRAPHY - Continued

R. D. Crepps, "Wire Roped Prestressed Concrete Pressure Pipe", A.C.I. Journal, June, 1943.

K. F. Billner and R. W. Carlson, "Electric Prestressing of Reinforcing Steel", A.C.I. Journal, June, 1943.

Dean Peabody, Jr., "Reinforced Concrete Structures", John Wiley Co.

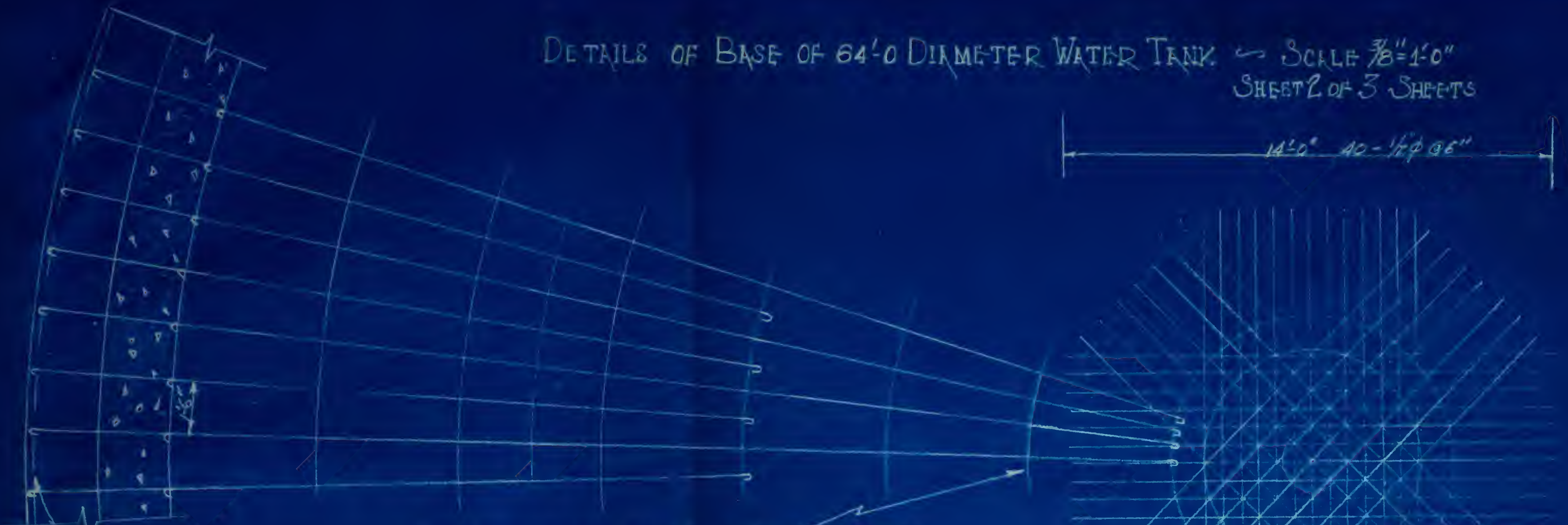
© 2000 Blackwell Science Ltd *Journal of Internal Medicine* 247: 399–405

Copyright © 2004 John Wiley & Sons, Ltd.

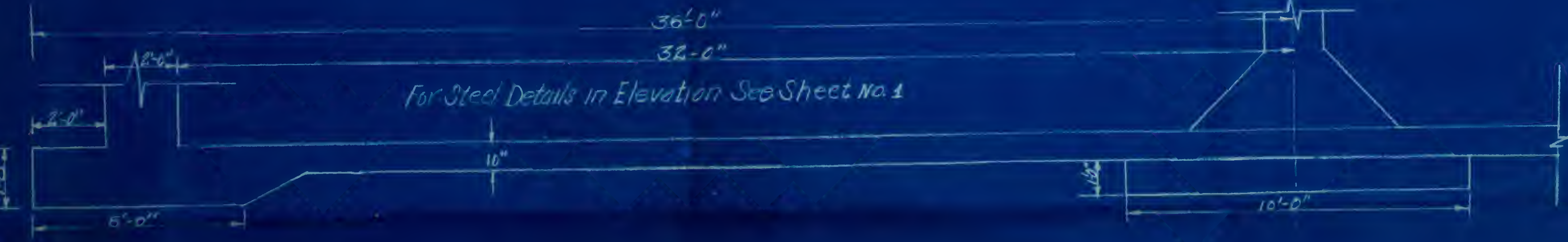
© 2012 John Wiley & Sons, Ltd. *J. Forecast.* 32, 1–16 (2013)
DOI: 10.1002/for



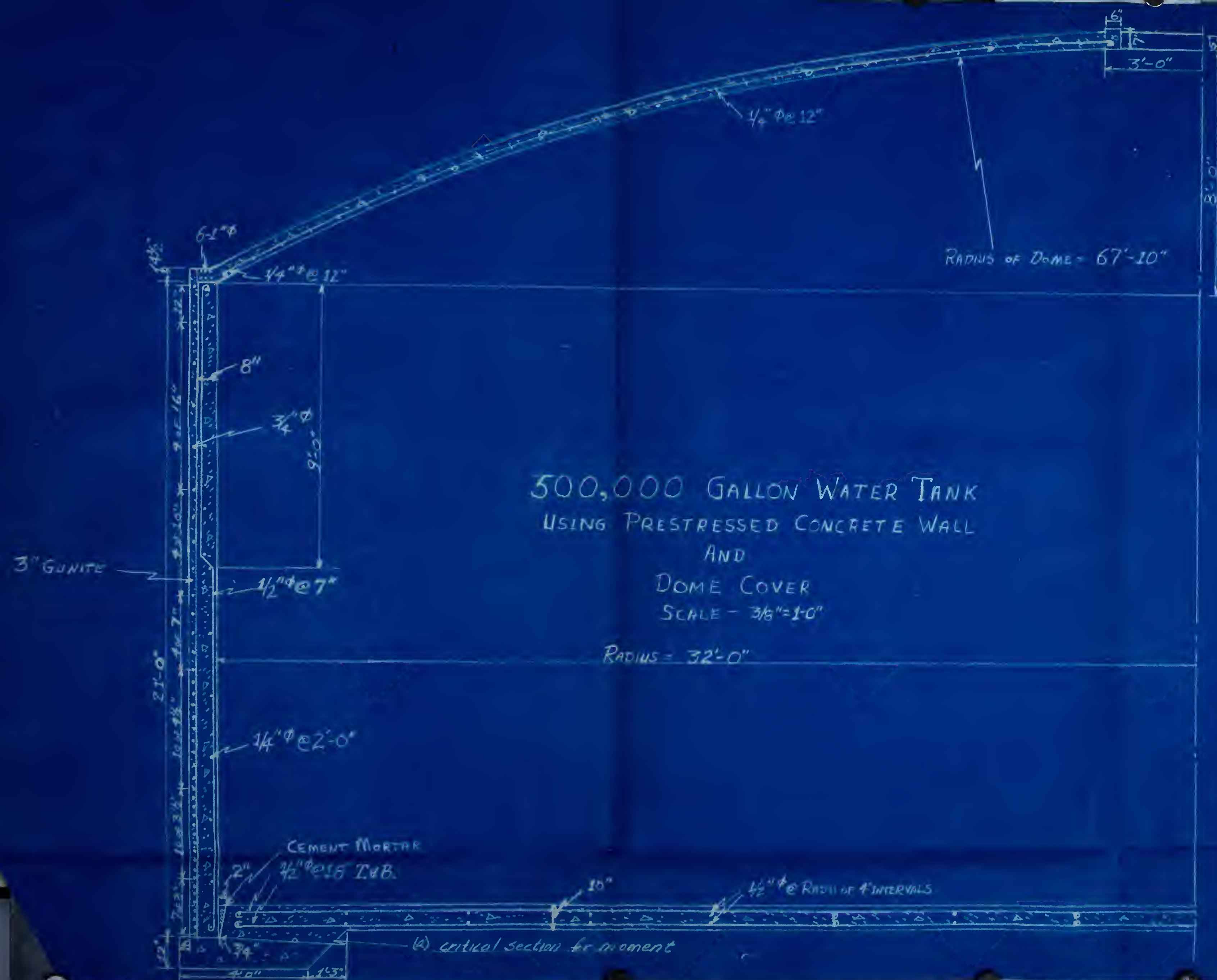
DETAILS OF BASE OF 64'-0 DIAMETER WATER TANK. → SCALE $\frac{3}{8}"=1'-0"$ SHEET 2 OF 3 SHEETS



2- $\frac{3}{4}"$ Top & Bottom
 8- $\frac{1}{2}"$ Spaced radially at 4'-0 = 32'-0 Top & Bottom
 Note: All bends shown are standard



For Steel Details in Elevation See Sheet No. 1



500,000 GALLON WATER TANK
 USING PRESTRESSED CONCRETE WALL
 AND
 DOME COVER
 SCALE - 3/8" = 1'-0"

RADIUS = 32'-0"

thesZ3

An investigation of prestressed concrete



3 2768 001 90416 2

DUDLEY KNOX LIBRARY